Executive Summary

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Observing the United States' Homelessness Crisis through Mathematical Methods

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March 3, 2024

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1 Introduction

Understanding the housing shortage has become more important than ever, as rates of homelessness have reached unprecedented and potentially dire level[1]. Moving into the future, it is undeniably critical for promoting the general welfare of United States populations to best understand housing for influencing public policy across major cities in the United States. Thus, we have prepared the following mathematical models to best understand such a trend.

2 It was the Best of Times

2.1 Restatement of the Problem

The first problem asks us to develop a mathematical model to predict changes to the housing supply over the next 50 years in two cities of our choosing: Seattle, Washington; and Albequerque, New Mexico.

2.2 Assumptions and Justifications

There will be no immense, drastic, and long-term permanent changes to housing production possibility within the next fifty years.

Justification: Events that will drastically change the ability to produce housing, such as immense wars or widespread natural disasters, are neigh-impossible to detect accurately with a simple mathematical model. The only events that can be accurately tracked through mathematical means over short periods of time are cyclical events, like economic recessions or inflation.

Occupied housing will not be considered part of the available total housing supply.

Justification: In regards to fixing the homelessness crisis, housing that can be considered available for allocation to unhoused people inherently must be unoccupied by others.

Differences in median housing costs and median income per capita across regions in both Albequerque and Seattle will not be considered in determining housing availability.

Justification: These factors hold a strong correlation with housing unavailability, yet we assume them to have no causal relationship.

2.3 Model Development

For our housing availability model, we choose to use a simple vector machine that regresses historical housing availiability data for both Albequerque and Seat-

tle, and from there, we cross-reference this data with historical economic trends across the United States to best model housing availability over time given cyclical economic trends.
To begin, we trained the model on the following datasets for housing availability in Albequerque and Seattle and the national GDP of the United States.

Year	Total housing units	Occupied units	Vacant units
2010	234,891	217,256	17,635
2011	237,735	220,060	17,675
2012	239,718	222,584	17,134
2013	240,277	222,491	17,786
2014	240,961	222,868	18,093
2015	241,326	222,098	19,228
2016	242,070	221,320	20,750
2017	243,402	221,119	22,283
2018	244,382	222,748	21,634
2019	245,476	224,166	21,310
2020	247,926	229,701	18,225
2021	252,924	236,191	16,733
2022	255,178	239,800	15,378

Table 1: Housing Statistics in Albequerque, New Mexico [2].

Year	Total housing units	Occupied units	Vacant units
2010	302,465	280,453	22,012
2011	304,164	282,480	21,684
2012	306,694	285,476	21,218
2013	309,205	288,439	20,766
2014	311,286	290,822	20,464
2015	315,950	296,633	19,317
2016	322,795	304,157	18,638
2017	334,739	314,850	19,889
2018	344,503	323,446	21,057
2019	354,475	331,836	22,639
2020	367,337	344,629	22,708
2021	362,809	337,361	25,448
2022	372,436	345,246	27,190

Table 2: Housing Statistics in Seattle, Washington [3].

Due to the limited size of the dataset, we chose to use a C value for our SVM closer to 1.0 to prevent overfitting or underfitting of the data.

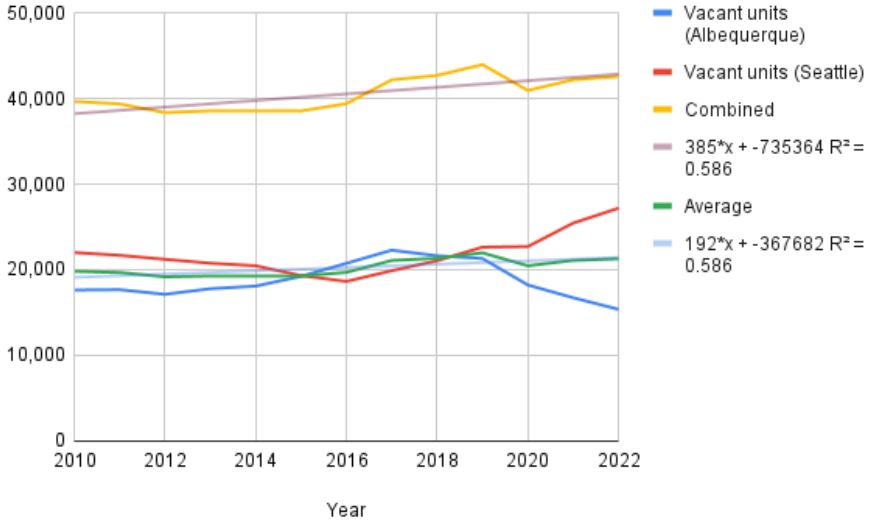

Figure 1: The number of vacancies in Albequerque and Seattle from 2010 to 2022 [2, 3].

Let $H(x)$ equal the number of available houses for a given year, where x is the current year (absolute from year 0, such as 2024). Simple regression on this dataset results in a total trendline of

$$H_{\text{TOTAL}}(x) = 385x - 735,364$$

where $R^2_{\text{TOTAL}} = 0.586$, and an average trendline of

$$H_{\text{AVG}}(x) = 192x - 367,682$$

where $R^2_{\text{AVG}} = 0.586$.

A coefficient of determination of 0.586 is undeniably subpar due to the immense indifficulty in representing vast differences across the trends with linear functions.

2.4 Results

With this model, we can predict the following housing statistics for 2034 (10 years in the future), 2044 (20 years in the future), and 2074 (50 years in the future):

Year	Years from 2024	Total Available Homes	Average Available Homes in Each City
2034	10	47,726	22,846
2044	20	51,576	24,766
2074	50	63,126	30,526

2.5 Reflecting on the Model

Overall, our model proves generally weak at predicting immense, unforseen changes to the economic situation of both cities such as the advent of war, the outbreak of a major epidemic/pandemic, or a large-scale natural disaster. This model is best for serving as a general, aggregate predictor of housing availability based on cyclical economic trends. Our coefficient of determination R^2 is certainly low, indicating a lack of accuracy, but this is certainly due to the difficulty of modeling previously-mentioned large-scale events with a linear model.

Altogether, we can conclude that this model's impact serves best as a general guideline for understanding realistic public policy because it is solely based largely on aggregate, cyclical economic factors that can be reasonably relied upon to occur continuously.

3 It was the Worst of Times

3.1 Restatement of the Problem

3.2 Assumptions and Justifications

3.3 Model Development

3.4 Results

3.5 Reflecting on the Model

4 Rising from this Abyss

4.1 Restatement of the Problem

4.2 Assumptions and Justifications

4.3 Model Development

4.4 Results

4.5 Reflecting on the Model

References

[1] Chris Arnold, Robert Benincasa, Jacqueline GaNun, and Haidee Chu. There's a massive housing shortage across the u.s. here's how bad it is where you live. *NPR Economy*, 14 July 2022. Accessed on 3 March 2024 https://www.npr.org/2022/07/14/1109345201/theres-a-massive-housing-shortage-across-the-u-s-heres-how-bad-it-

[2] U.S. Census Bureau. Selected housing characteristics. U.S. Census Bureau. Accessed on 3 March 2024. https://data.census.gov/table/ACSDP1Y2010.DP04?q=albquerque%20city%20DP04&g=160XX00US5363000.

[3] U.S. Census Bureau. Selected housing characteristics. U.S. Census Bureau. Accessed on 3 March 2024. https://data.census.gov/table/ACSDP5Y2010.DP04?q=seattle%20city%20DP04&g=160XX00US5363000&hidePreview=false&vintage=2018&layer=VT_2018_160_00_PY_D1&cid=DP04_0001E&tid=ACSDP5Y2018.DP04.